evapco®

# ICE-PAK™ Ice-Chilled-Energy Storage Units

## Featuring Extra-Pak® Ice Coil Technology


**Engineered Modular Ice Tanks**

**Designed for Thermal Ice Storage Systems**

**Capacities to 1000 Ton-Hours**

U.S. Green Building Council Member

GreenSpec® LISTED
www.GreenSpec.com


## Worldwide Corporate Headquarters

Since its founding in 1976, EVAPCO, Incorporated has become an industry leader in the engineering and manufacturing of quality heat transfer products around the world. EVAPCO's mission is to provide first class service and quality products for the following markets:

- Commercial HVAC
- District Energy
- Industrial Process
- Industrial Refrigeration
- Power

EVAPCO's powerful combination of financial strength and technical expertise has established the company as a recognized manufacturer of market-leading products on a worldwide basis. EVAPCO is also recognized for the superior technology of their environmentally friendly product innovations in sound reduction and water management.

EVAPCO is an employee owned company with a strong emphasis on research & development and modern manufacturing plants. EVAPCO has earned a reputation for technological innovation and superior product quality by featuring products that are designed to offer these operating advantages:

- Higher System Efficiency
- Environmentally Friendly
- Lower Annual Operating Costs
- Reliable, Simple Operation and Maintenance

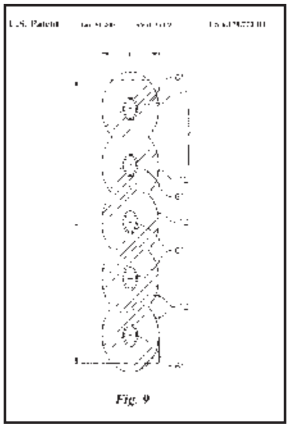
With an ongoing commitment to Research & Development programs, EVAPCO provides the most advanced products in the industry – **Technology for the Future, Available Today**!

EVAPCO products are manufactured in 20 locations in 9 countries around the world and supplied through a sales network consisting of over 170 offices.

## Experience, Innovation, Guaranteed Performance

EVAPCO engineers are credited as inventors on more than 45 U.S. Patents and their foreign counterparts. This engineering expertise speaks for itself and provides an exceptional foundation for various product development projects. This foundation is the catalyst for providing customer driven features and benefits in an environmentally safe manner.

ICE-PAK™ Ice-Chilled-Energy storage units feature EVAPCO's patented Extra-Pak® ice coil technology* with elliptical tubes that that increase packing efficiency over round tube designs. This technology yields optimum performance and compact use of space.




The state of the art Research & Development Center, located at EVAPCO's World Headquarters in Taneytown, Maryland USA, has over 60,000 square feet dedicated to thermal analysis and product development. Experienced R&D engineers perform product and application research year round in six environment al test chambers.


The Research & Development Center features customized laboratories that are designed to conduct tests through a wide range of environmental conditions. The computerized data acquisition system records the data and graphically displays continuous results, thereby providing the R&D engineers with valuable test information on a continuous basis. In addition, the R&D Center houses an ice thermal storage system with glycol chiller for developing charge and discharge performance ratings, product improvements and ice storage system controls.

EVAPCO products are the result of extensive research and thermal testing. As a result, EVAPCO products deliver guaranteed performance in order to maximize system performance.

*US Patent No. 6,178,770 B1

# Design and Construction Features

### HIGH-DENSITY INSULATION

- Fully isolates tank from structure – no cold bridges
- R-19.5 sides
- R-13 bottom and top

### HEAVY-DUTY STEEL COIL

- Exclusive EXTRA-PAK® coil technology*
- ASME B31.5 design and construction
- 300 psig working pressure
- Hot-dip galvanized after fabrication
- Connections grooved for mechanical coupling

### REMOVABLE ACCESS COVER

- Large size – 20" x 34"
- Easily handled – 15 lbs.
- Fully insulated


### HEAVY-DUTY CONSTRUCTION

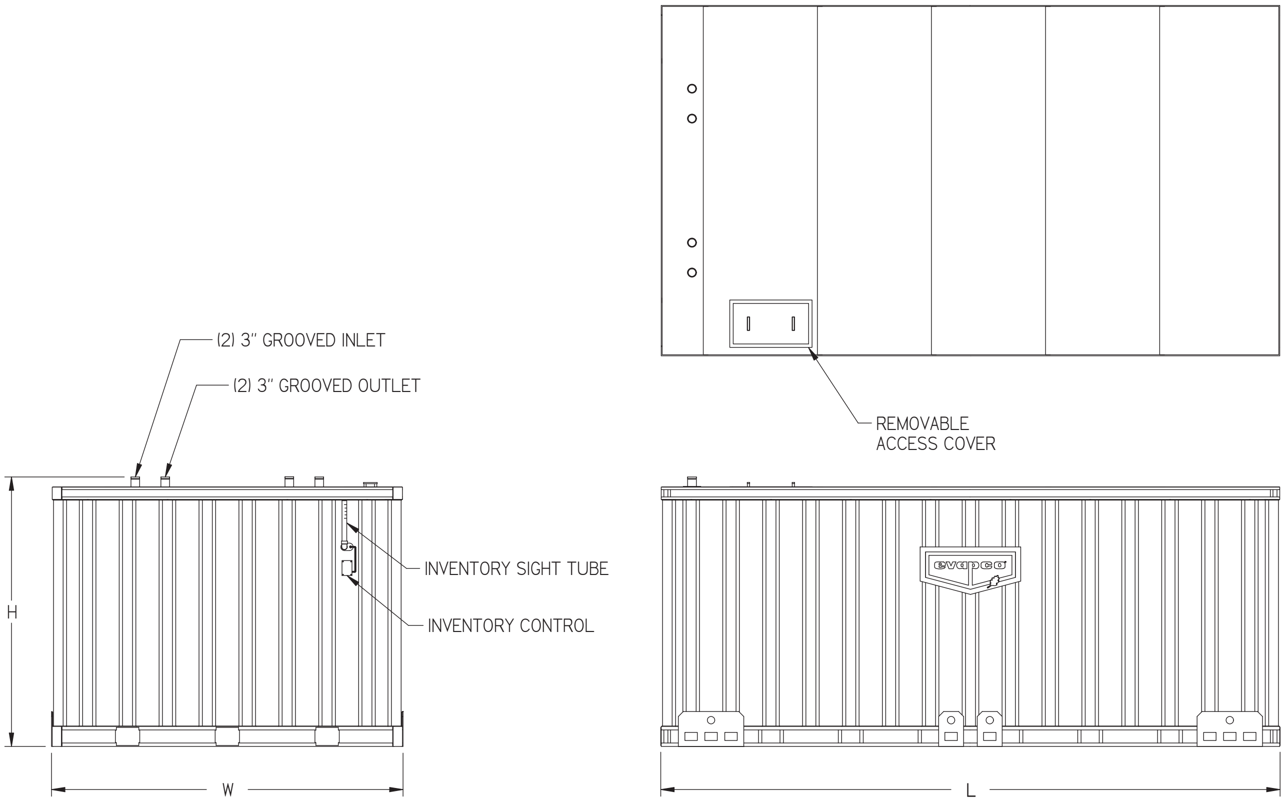
- Corrosion-resistant stainless steel tank, welded water-tight
- G-235 hot-dip galvanized steel structural supports
- G-235 hot-dip galvanized steel panels protect insulation

### INVENTORY MEASUREMENT AND CONTROL

- Clear sight tube for viewing water level
- Electronic controller with 4-20 mA output signal
- Mechanical relays for ice charge termination and low level alarm

*US Patent No. 6,178,770 B1

# Engineering Data & Dimensions




| Model No. | Latent Capacity Ton-Hours | Weights (LBS) | | Volumes (GAL) | | Dimensions | | |
|---|---|---|---|---|---|---|---|---|
| | | Shipping | Operating | Tank Water | Coil Glycol | W | L | H |
| ICE-370TD | 370 | 20,550 | 57,570 | 4,115 | 355 | 7' 10" | 20' 8" | 7' 6" |
| ICE-480TD | 480 | 24,580 | 72,760 | 5,345 | 460 | 9' 10" | 20' 8" | 7' 6" |
| ICE-590TD | 590 | 28,320 | 87,970 | 6,610 | 565 | 11' 10" | 20' 8" | 7' 6" |
| ICE-476TE | 476 | 23,650 | 75,380 | 5,775 | 455 | 7' 10" | 20' 8" | 9' 0" |
| ICE-620TE | 620 | 28,160 | 95,420 | 7,495 | 590 | 9' 10" | 20' 8" | 9' 0" |
| ICE-760TE | 760 | 32,730 | 115,740 | 9,245 | 725 | 11' 10" | 20' 8" | 9' 0" |
| ICE-625TH | 625 | 29,530 | 89,460 | 6,600 | 600 | 7' 10" | 20' 8" | 11' 3" |
| ICE-815TH | 815 | 34,790 | 113,230 | 8,670 | 750 | 9' 10" | 20' 8" | 11' 3" |
| ICE-1000TH | 1,000 | 40,890 | 137,160 | 10,590 | 955 | 11' 10" | 20' 8" | 11' 3" |

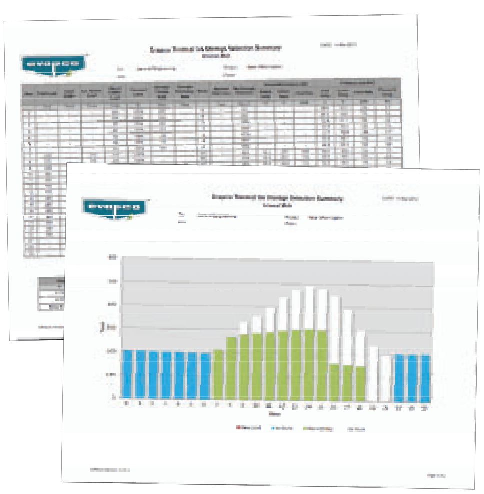
# Selection and Performance

Whether the application is air conditioning or process cooling, an accurate design day cooling load profile is recommended for sizing ICE-PAK™ Ice-Chilled-Energy storage units and other system components. Before selecting the system components, it is necessary to make decisions regarding the overall system operation. Consider the following:

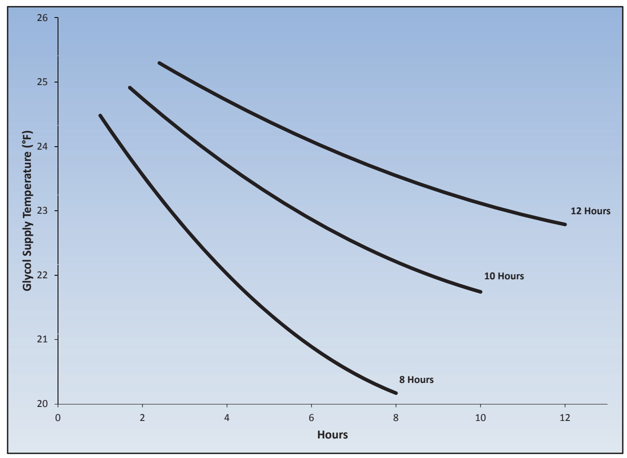
1. Review the electric utility company's applicable schedules or tariffs to understand peak demand and hourly energy costs.
2. Review the design day hourly cooling load profile and determine if full storage or partial storage system design is preferred. Note that full storage system design should generally be considered only where peak electrical supplies are limited and/or energy costs are very high.
3. Review the design day hourly cooling load profile and determine if base load or conventional water chillers will be necessary for cooling during on-peak and off-peak hours.
4. Determine the chilled water system design flow and delta-T.
5. Determine low temperature supply capability of available or desired glycol chillers.

In summary, the selection process requires defining the 24-hour design day loads and operating strategy for chillers and ice (see page 6 for system operating modes), flows and temperatures, chiller size and temperature limitations. Based on this information, EVAPCO can provide a custom solution using its evapSelect® computer selection software.

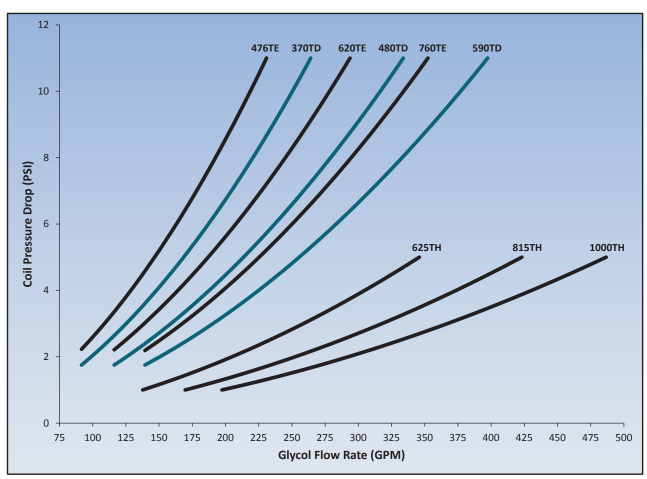
The system design solution is reported in a format as recommended by AHRI Guideline T. Data includes quantity and size of ICE storage units, minimum required chiller size, hourly glycol and base water chiller capacities, net ice in storage, and primary/secondary loop flows and temperatures. A chart that graphically represents system operation is also included. An example of the report is shown below.

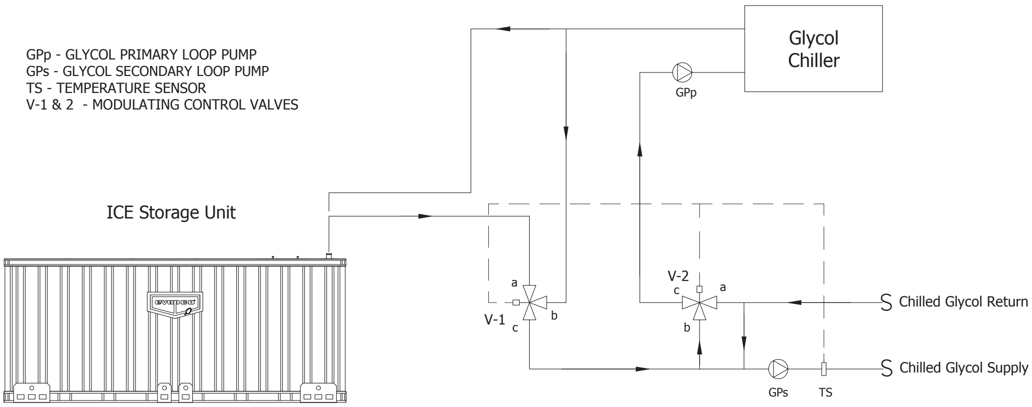


Size of the glycol chiller is largely determined by the time available to build ice. Larger chillers are required to build ice in shorter periods of time. At the start of the ice build mode, the chiller capacity and glycol supply temperature will be high. As the ice build process continues, the ice will become thicker requiring a lower glycol temperature resulting in reduced chiller capacity. Chillers sized to build ice in shorter periods of time must also have a lower temperature supply capability (see chart below).




ICE-PAK™ Ice-Chilled-Energy storage units are designed to minimize operating costs, including pumping energy. Pressure drop through the ICE storage coils is low and comparable to other heat exchangers that may be used in the system. Below is a chart showing coil pressure drop for a range of unit flow rates using 25% ethylene glycol heat transfer solution.






# System Operating Modes

The cooling system controls or building automation system must vary the modes of operation based on time-of-day, predicted cooling profile, or season of the year. Any or all of the operating modes described below may be used daily.

**Ice Build** – Low temperature glycol is circulated through the ICE storage coils to build ice. Ice build will begin when the bulk tank water temperature is below freezing and continue until a full build is reached. The leaving glycol temperature required from the chiller will decrease throughout the build cycle. The chiller must be selected to supply the lowest temperature required based on the Summary Selection sheet. This may be 22°F or lower at the end of the build cycle. The chiller should operate at full load (100% capacity) during the ice build period. To keep the chiller from unloading, it is a common practice to set the leaving temperature of the chiller at 2°F below the final build temperature (in this case 20°F). This will assure that the chiller remains fully loaded. Ice build continues until terminated by the ice inventory control or operating mode is changed.

Components Settings: Chiller set to supply 20°F glycol. Glycol Pump GPp is on and Glycol Pump GPs is off. Valve V-1 ports a > c, Valve V-2 ports b > c.

**Chiller Only Direct Cooling** – The direct cooling mode is intended to provide cooling directly from the chiller to the cooling loop. Often this mode is used after ice build is completed and prior to the on-peak period while energy prices are still low. All cooling is satisfied by the chiller, thus saving the ice inventory for use during the high price on-peak period. If the cooling load is greater than expected, a small amount of ice storage may be needed to reduce glycol supply temperature during this period. Ideally, this mode should maximize chiller use and minimize ice storage use.

Components Settings: Chiller is reset to supply the desired system cooling loop temperature, 42°F for example. Glycol Pumps GPp and GPs are on. Valve V-1 ports b > c, Valve V-2 ports a > c. If the chiller is unable to handle the cooling load and the supply temperature to the cooling loop is higher than desired, temperature sensor TS can modulate Valve V-1 to provide supplemental cooling from storage.

**Chiller and Ice Melt** – The chiller operates in combination with the ice storage to meet the cooling needs. The ideal arrangement is to have the chiller and ice storage piped in series with the ice storage located downstream, as shown in the schematic above. The glycol chiller's supply temperature set point can be reset to a temperature of say 45°F. For a system designed for an 18°F delta-T, the chiller would provide the cooling from 56°F to 45°F and the ice storage would provide the final cooling to 38°F. Locating the chiller upstream of the ice storage allows for a higher chiller leaving set point of 45°F and better chiller efficiency. The chiller may cycle off automatically when the return temperature approaches the 45°F set point. When this occurs, the partial storage system becomes a full storage system.

Components Settings: Chiller is reset to provide 45°F. Glycol Pumps GPp and GPs are on. Valve V-1 modulates flow in response to TS to provide 38°F, Valve V-2 ports a > c.

**Ice Melt Only** – As the name implies, all cooling is provided by the ICE storage system. Chiller and condenser heat rejection components are turned off. Only the glycol primary and secondary loop pumps will operate.

Components Settings: Chiller is off. Glycol Pumps GPp and GPs are on. Valve V-1 modulates flow in response to TS to provide 38°F, Valve V-2 ports a > c.

**Ice Build with Cooling** – Small, nighttime loads (no greater than 10% of design) may be cooled by the system during the ice build process by modulating control Valve V-2 to blend some of the glycol returning from the ICE storage coils fluid into the secondary loop. The secondary loop return fluid is mixed with the remainder of the glycol build fluid and returned to the chiller.

Components Settings: Chiller set to supply 20°F glycol. Glycol Pumps GPp and GPs are on. Valve V-1 ports a > c, Valve V-2 modulates flow in response to TS to meet nighttime secondary loop supply set point temperature, 42°F for example.

# Mechanical Specifications

Furnish and install internal melt, hot-dip galvanized ice coils with factory-assembled, insulated, steel tank. System design and performance is based on EVAPCO model __________ modular ice tank with a net latent storage capacity of __________ ton-hours.

## Coil Construction

Coils shall be designed and manufactured to meet the requirements of ASME Code B31.5 and rated for 300 psig working pressure.

Coils shall be configured to provide countercurrent glycol flow in adjacent circuits. Coil circuits shall be constructed of continuous 1.05" O.D. all prime surface high frequency induction welded ASTM A-1008 Carbon Steel Type B tubing. The steel tubing shall be nominal 16 gauge thickness, formed into an ellipse, and eddy current tested for continuous in-process testing. Full-length circuits with no intermediate butt welds shall be formed into serpentines and individually leak tested with air under water prior to being welded into Schedule 40 ASTM SA-53 Carbon Steel Type E, Grade B pipe headers. Headers and connecting piping shall be sized for maximum fluid velocity of 10 ft/sec.

Coil circuits, intermediate tube sheets, headers and connecting piping shall be assembled into a heavy-duty steel frame. The completed coil assembly shall be leak tested with 400 psig air pressure under water for a minimum of fifteen (15) minutes. The coils shall be then hot-dip galvanized in a zinc bath deep enough for full, uniform coverage per ASTM A123/A123M with minimum Coating Grade 45. After galvanizing, the coil assembly shall again be leak tested with 400 psig air pressure under water for fifteen (15) minutes. Coils shall then be mounted on hot-dip galvanized structural supports. Finished coil connections shall be grooved for mechanical coupling.

## Tank Construction And Insulation

Tank shall be constructed of heavy-gauge (minimum 12 gauge) stainless steels (Types 304 and 439) with all seams welded watertight. All floor, wall and cover support structural members shall be constructed of G-235 hot-dip galvanized steel and thermally isolated from the tank to avoid condensation on exterior surfaces. Tank walls shall be covered with 3" of high density polyisocyanurate insulation, having a net thermal resistance (R-value) of 19.5 hr-ft$^2$-°F/BTU. Tank floor and top covers shall be insulated with 2" of high density polyisocyanurate, having a net thermal resistance (R-value) of 13 hr-ft$^2$-°F/BTU.

Tank walls and insulation shall be protected by hot-dip galvanized panels. Top of tank shall be covered with hot-dip galvanized panels, supported by structural members designed to handle external loads of 300 lbs/ft$^2$, and sealed to be rain-tight. A large (4 sq. ft. minimum), removable, insulated access cover shall be provided for visual inspection of the ice coil.

A clear PVC sight tube shall be provided for visual indication of water level and ice inventory. A removable cover shall be provided to avoid shipping damage and prevent algae growth due to direct sunlight.

## Ice Inventory Control

The ice tank shall be provided with an electronic ice inventory controller that measures tank water level changes in direct proportion to change in ice volume on the coil. Outputs shall include a 4-20 mA analog signal and mechanical relays for low level alarm and high level ice charge termination.

## Heat Transfer Fluid Quality

Coils shall be filled with an industrial grade ethylene or propylene glycol, premixed with distilled or deionized water and corrosion inhibitors suitable for all materials found in the ice storage system (copper, brass and steel). Dow Chemical Company products DOWTHERM SR-1 (ethylene glycol) and DOWFROST HD (propylene glycol) shall be the minimum acceptable level of quality.

## Tank Water Quality

Ice tank shall be filled with clean, fresh water meeting the following quality guidelines.

| | |
|---|---|
| pH | 7.0 to 8.2 |
| Hardness as CaCO3 | 50 to 500 ppm |
| Sulfates | 250 ppm maximum |
| Alkalinity as CaCO3 | 75 to 400 ppm |
| Chlorides as Cl | 125 ppm maximum |
| Total Dissolved Solids | 1000 ppm maximum |

# EVAPCO PRODUCTS ARE MANUFACTURED WORLDWIDE.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